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SECOND QUARTERLY REPORT
R-310.2-53, PIB-249.2

on

MEASUREMENT OF RADIO FREQUENCY CABLE

February 1, 1953 to April 30, 1953

for

BUREAU OF SHIPS
Contract NObsr-63084
Index No. NE-111616, Subtask 10

MRI

POLYTECHNIC INSTITUTE OF BROOKLYN
MICROWAVE RESEARCH INSTITUTE

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Microwave Research Institute
Polytechnic Institute of Brooklyn
55 Johnson Street
Brooklyn 1, New York

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MEASUREMENT OF RADIO FREQUENCY CABLE

February 1, 1953 to April 30, 1953
Prepared under Contract NObsr-63084
for
Bureau of Ships

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John W.E. Griemsmann
Associate Director

Saul W. Rosenthal
Research Associate

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Ernst Weber
Director

Title Page
Abstract
5 Pages of Text
1 Table
8 Pages of Figures

Brooklyn 1, New York
June 11, 1953

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ABSTRACT

An outline is given of the work being done in the program for attenuation measurements of radio frequency cables and the evaluation of cable construction as it affects its attenuation and leakage. Results of measurements are given and efforts and plans for implementing the program are discussed. The emphasis is placed on frequencies between 2500 mc/sec to 10,000 mc/sec where anomalous attenuation behavior has been experienced.

I. Introduction

The purpose of this contract is to conduct a measurements program on the attenuation and leakage parameters of cables over a frequency range of from 100 to 10,000 mc/sec. These measurements will bring up to date the attenuation specifications of available cables listed in the publication, "Attenuation of Standard RF Cables", Bureau of Ships, Code 817, dated May 1952 and where possible extend the frequency range to 10,000 mc/sec. The program will also include a limited investigation of attenuation in the region of 3000 to 10,000 mc/sec as a function of cable construction.

A number of test cables have been received and measurements have been initiated starting at 2500 mc/sec. At the same time, the procurement of both test samples and connecters has been continued. The special cables needed for the evaluation of cable construction as it affects attenuation above 3000 mc/sec have been decided upon and the necessary steps for the procurement of these cables are being taken. In addition, the reports, describing the attenuation measurements that resulted in the publication cited above, have been received and are being studied.

II. Work in Progress

A. Procurement of Test Samples

The total number of sample cables so far received have been the following:

1. RG-5A/U,350 ft.
2. RG-9A/U,350 ft.
3. RG-10A/U,521 ft.
4. RG-21/U,200 ft.
5. RG-116/U,143 ft. 10 inches
6. RG-118/U,500 ft.
7. RG-11/U,250 ft.
8. RG-85/U,300 ft.

In addition and in order to expedite the measurement program the following cables have been purchased by Polytechnic Institute of Brooklyn:

9. RG-58A/U,200 ft.
10. RG-8/U,300 ft.
11. RG-55/U,300 ft.

In connection with the evaluation of cable construction as it affects attenuation above 3000 mc/sec the following special samples have been decided upon after consultation with both members of the services and representative of some cable companies. These have been chosen as a

starting point in obtaining information for a reasonable evaluation. It has been decided to use both RG-8/U and RG-9A/U as a base and test variations on each in order to determine the effect of the different types of cable construction. These two cables were chosen because in many respects they are similar, except for the double braid construction of RG-9A/U, and seem to have the same attenuation characteristics up to approximately 3000 mc/sec. Above 3000 mc/sec, the attenuation characteristics change sharply and this investigation is an effort to determine what feature of braid construction is responsible. It was decided to have the following test cables made and steps are being taken to initiate the procurement of the samples.

1. RG-9A/U Core - Single RG8 type silver copper braid.
2. " " - Single RG9 type " " " (1st braid).
3. RG-9A/U Cable with double Cu braid in place of silver coated Cu.
4. RG-9A/U " with a thin dielectric between the two braids.
5. RG-9A/U " " " thick " " " " "
6. RG-9A/U Core - Single RG8 type silver coated copper braid and armour with dielectric in place of the jacketing material.
7. RG-9A/U Cable with 1st braid RG8 type silver coated Cu braid: all else the same.

B. Procurement of Connectors

Connectors and adapters have been obtained for most of the cables involved in the measurement program. Additional ones are on order and should be available shortly.

C. Measurement Program

Measurements were started on a group of six (6) cables that were received in the early part of the period. It was decided to carry the measurements thru from 2800 mc/sec to 10,000 mc/sec for the first group of cables. The first group includes the following cables:

Cable Type	Total Length	Connectors Used	Nominal Impedance
1. RG-5A/U	350 ft.	UG-18C/U, UG-20C/U	50.0
2. RG-9A/U	350 ft.	UG-21D/U, UG-23D/U	51.0
3. RG-21/U	200 ft.	UG-18C/U, UG-20C/U	53.0
4. RG116/U	143 ft.10in.	UG-21D/U, UG-23D/U	50.0
5. RG-11/U	250 ft.	UG-21D/U, UG-23D/U*	75.0
6. RG58A/U	200 ft.	UG-88/U, UG-89/U	52.0

*Special UG-21D/U and 23D/U connectors designed for 75 ohms.

The cables were measured with the Ballantine Voltmeter attenuator measuring set-up using buffer cables as described in the first report and as shown in Fig. MRI-13097. In each case and for each frequency the buffer cables were cut to lengths that would have approximately 13 to 20db of attenuation and the samples, a minimum of two for each type of cable, cut to lengths for an attenuation in the range of from 15 to 40db. In addition, the samples were also measured using a straight Ballantine attenuation measuring set and using matching techniques, Fig. MRI-13096. These results were compared to those of the buffer method. For cables with a 50 ohm impedance the results of the two methods checked on the average within .3 d b .

For each method 3 or more readings were taken on each sample and the final value was taken as the average of the values for all samples of each type tested. In the case where cables less than 100 ft. were used it was necessary to use a multiplying factor in order to arrive at the db/100 ft. This would increase the possible error by that same factor and therefore the table of data indicates the length of cable sample involved for the particular frequency.

The results of the measurements up to 4000 mc/sec are tabulated in Table I and curves of attenuation vs. frequency are given from the same data, Figs. MRI-13287 thru Fig. MRI-13292.

The measurement program is being continued and upon completion of measurements at all the frequencies for the first group, a second group of cables, that have been received or purchased in the interim, will be measured.

D. Study Program

The following reports were received from the Office of Naval Research in a letter dated March 23, 1953. It includes 52 reports as listed in a letter from Chief, Bureau of Ships, dated March 18, 1953, to be used in work on this contract. The reports are as follows:

(1) USNUSL rpt NP24/S67/9-8(D2C1) WKG/mmf Ser 1311-419 dtd 5 Oct 1951
(2) SCEL rpt T-2582 dtd 8 March 1950
(3) SCEL rpt T-3073 dtd 3 Feb 1951
(4) SCEL rpt T-3042 dtd 27 Nov 1950
(5) SCEL rpt T-3565 dtd 8 Aug 1952
(6) SCEL rpt T-3657 dtd 13 Dec 1952
(7) M.L. rpt 4960-A62.2-1 Part 3 (final) dtd 26 Oct 1948
(8) M.L. rpt 4960-A62.2-11 dtd 18 Jan 1950
(9) M.L. rpt 4960-A62.2-14 dtd 6 Mar 1950
(10) M.L. rpt 4960-A62.2-16 dtd 20 Feb 1950
(11) M.L. rpt 4960-A62.2-17 dtd 1 May 1950
(12) M.L. rpt 4960A-62.2-23 dtd 28 Dec 1950

(13) M.L. rpt 4960-A-A62.2-24 dtd 23 Jan 1953
(14) M.L. rpt 4960-A-62.2-58 dtd 8 Apr 1952
(15) SCEL rpt T-3448 dtd 18 Apr 1952
(16) M.L. rpt 4960-A62.2-29 dtd 26 Mar 1951
(17) M.L. rpt 4960-A-A62.2-34 dtd 21 Jun 1951
(18) M.L. rpt 4960-A-62.2-55 dtd 5 Oct 1951
(19) M.L. rpt 4960-A-62.2-58 dtd 8 Apr 1952
(20) M.L. rpt 4960-A-62.2-60 dtd 30 Jun 1952
(21) M.L. rpt 4960-A-62.2-121 dtd 24 Feb 1953
(22) NRL rpt S67/62-301a R-301-555 agm dtd 30 Sep 1944
(23) SCEL rpt T-3044 dtd 3 Jan 1951
(24) M.L.rpt 4960-A62.2-5 dtd 16 Sep 1949
(25) M.L. rpt 4960-A62.2-8 dtd 19 Oct 1949
(26) NRL rpt R-S67/62(341C-2) R-341-407/45 lel dtd 12 Apr 1945
(27) M.L. rpt 4960-A-62.2-20 dtd 28 Jul 1950
(28) M.L. rpt 4960-A-62.2-53 dtd 7 Sep 1951
(29) M.L. rpt 4960-A-62.2-59 dtd 1 Apr 1952
(30) M.L. rpt 4960-A62.2-3 Part 1 Prog 1 dtd 19 Jan 1949
(31) M.L. rpt 4960-A-62.2-109 dtd 3 Dec 1952
(32) SCEL rpt T-3045 dtd 12 Dec 1950
(33) SCEL rpt T-3684 dtd 30 Jan 1953
(34) AF rpt MCREE-50-3 dtd 25 Oct 1949
(35) M.L. rpt 4960-A62.2-7 dtd 22 Jul 1949
(36) M.L. rpt 4960-A62.2-9 Prog 1 dtd 31 Mar 1949
(37) M.L. rpt 4960-A-49.3-40 dtd 30 Jan 1952
(38) SCEL rpt T-3041 dtd 3 Feb 1951
(39) SCEL rpt Proj 4302A-3 Test rpt 12655 dtd 15 Nov 1950
(40) M.L. rpt 4960-A-62.2-103 and 105 dtd 6 Nov 1952
(41) NRL rpt R-S67/62(341C-2) R-341-35830/45 dtd 14 Jan 1945
(42) M.L. rpt 4960A-A62.2-42 dtd 13 Jul 1951
(43) M.L. rpt 4960-A-62.2-123 dtd 9 Feb 1953
(44) AF rpt MCREE-49-23 dtd 4 Mar 1949
(45) AF rpt MCREE-50-21 dtd 24 Apr 1950
(46) M.L. rpt 4960-A-A62.2-35 dtd 26 Jul 1951
(47) M.L. rpt 4960-A-62.2-100 dtd 20 May 1952
(48) M.L. rpt 4960-A-62.2-4A dtd 20 Dec 1950
(49) M.L. rpt 4960-B-25.2 dtd 19 Nov 1951
(50) M.L. rpt 4960-A62.2-12 dtd 10 Feb 1950
(51) M.L. rpt 4960-A-A62.2-21 dtd 14 Dec 1950
(52) M.L. rpt 4960-A-A62.2-33 dtd 9 Aug 1951

The work in the reports are currently being studied and an evaluation in terms of our program is being made.

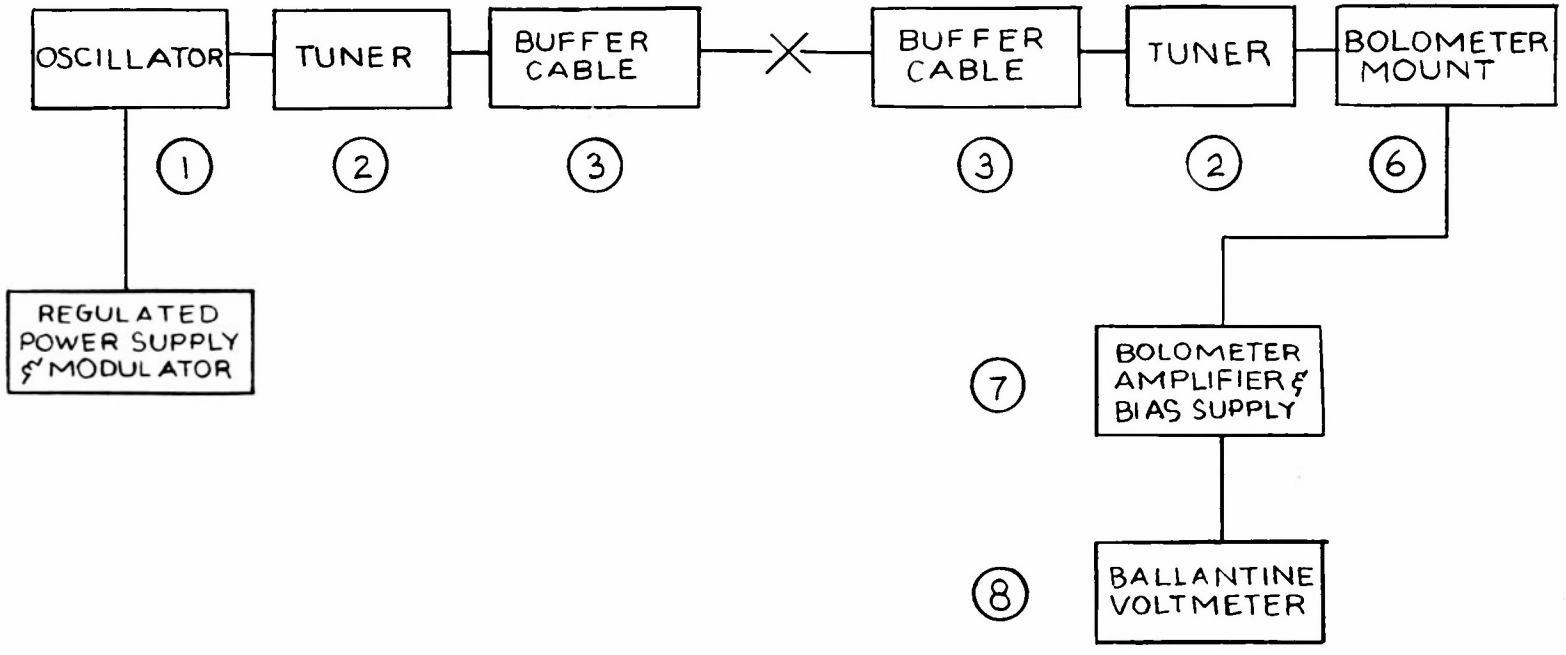
III. Identification of Personnel

The above work is being carried out thru the efforts of the following personnel:

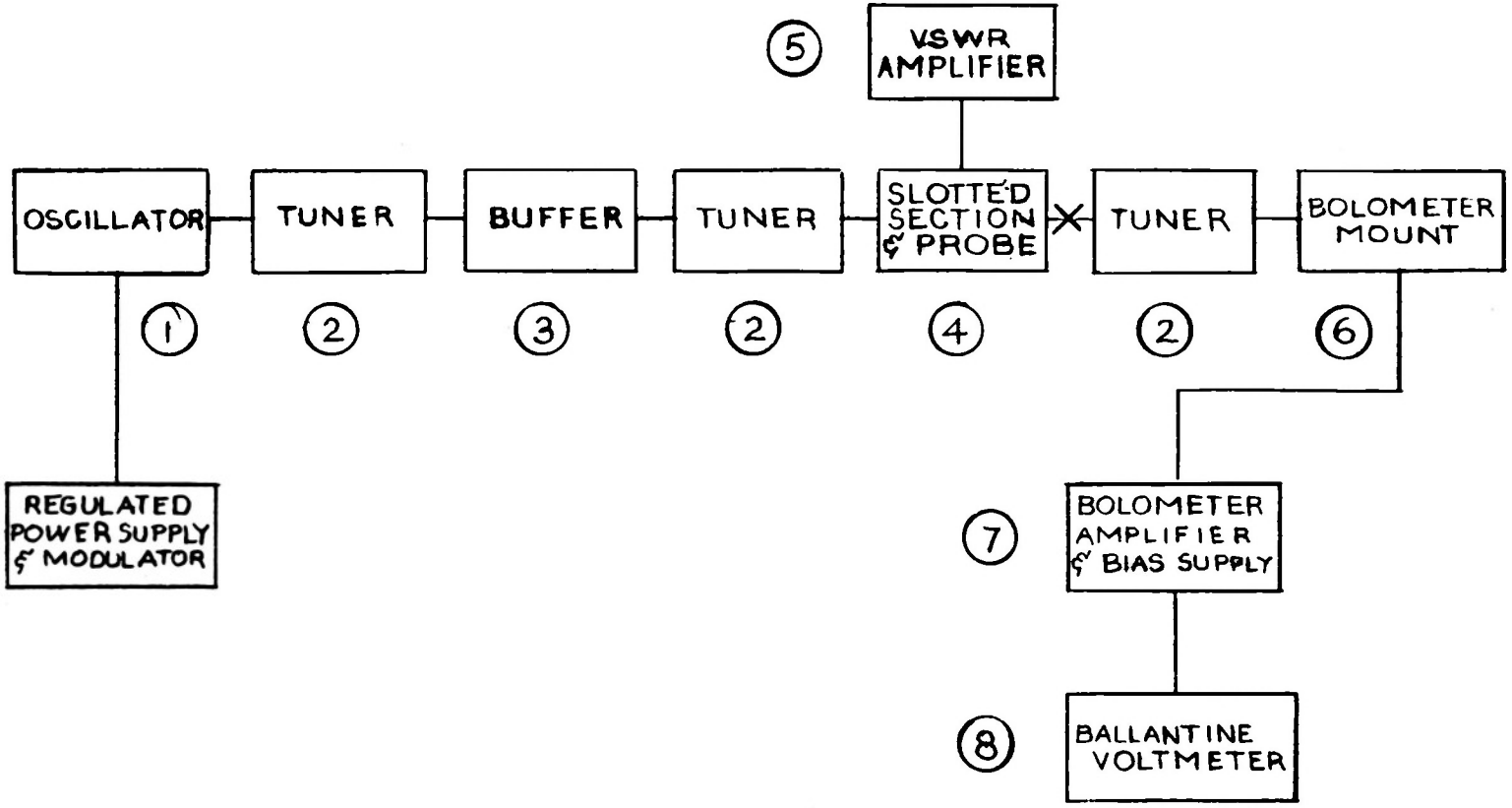
Dr. J.W.E. Griemsmann	Associate Director	Part Time
Mr. S.W. Rosenthal	Research Associate	" "
Mr. L. Rubenstein	Technician	Full Time

TABLE I

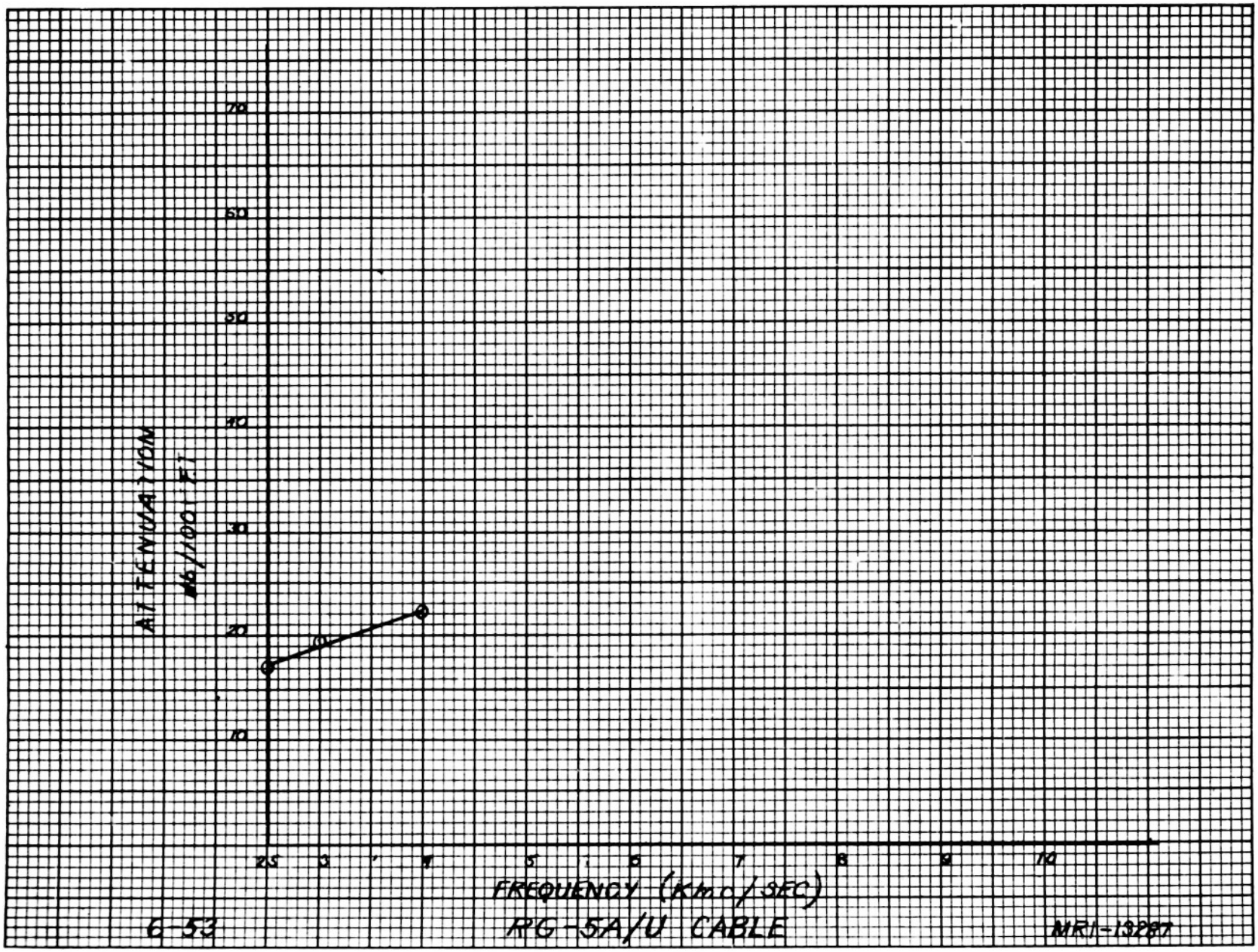
Frequency	Cable Type	Sample Lengths	Average Att/100ft Buffer Method
2500 mc	RG-5A/U	50'; 100'	17.35
	RG-9A/U	50'; 100'	16.4
	RG-11/U	30'; 75'	15.45
	RG-21/U	15'; 25'	71.2
	RG-58/U	30'; 50'	45.1
	RG-116/U	40'; 100'	13.55
3000 mc	RG-5A/U	50'; 100'	19.65
	RG-9A/U	50'; 100'	18.2
	RG-11/U	30'; 75'	17.2
	RG-21/U	15'; 25'	80.9
	RG-58/U	30'; 50'	52.7
	RG-116/U	40'; 100'	15.95
4000 mc	RG-5A/U	50'; 100'	22.4
	RG-9A/U	50'; 100'	22.4
	RG-11/U	30'; 75'	22.75
	RG-21/U	15'; 25'	96
	RG-58/U	30'; 50'	67.45
	RG-116/U	40'; 100'	19.2



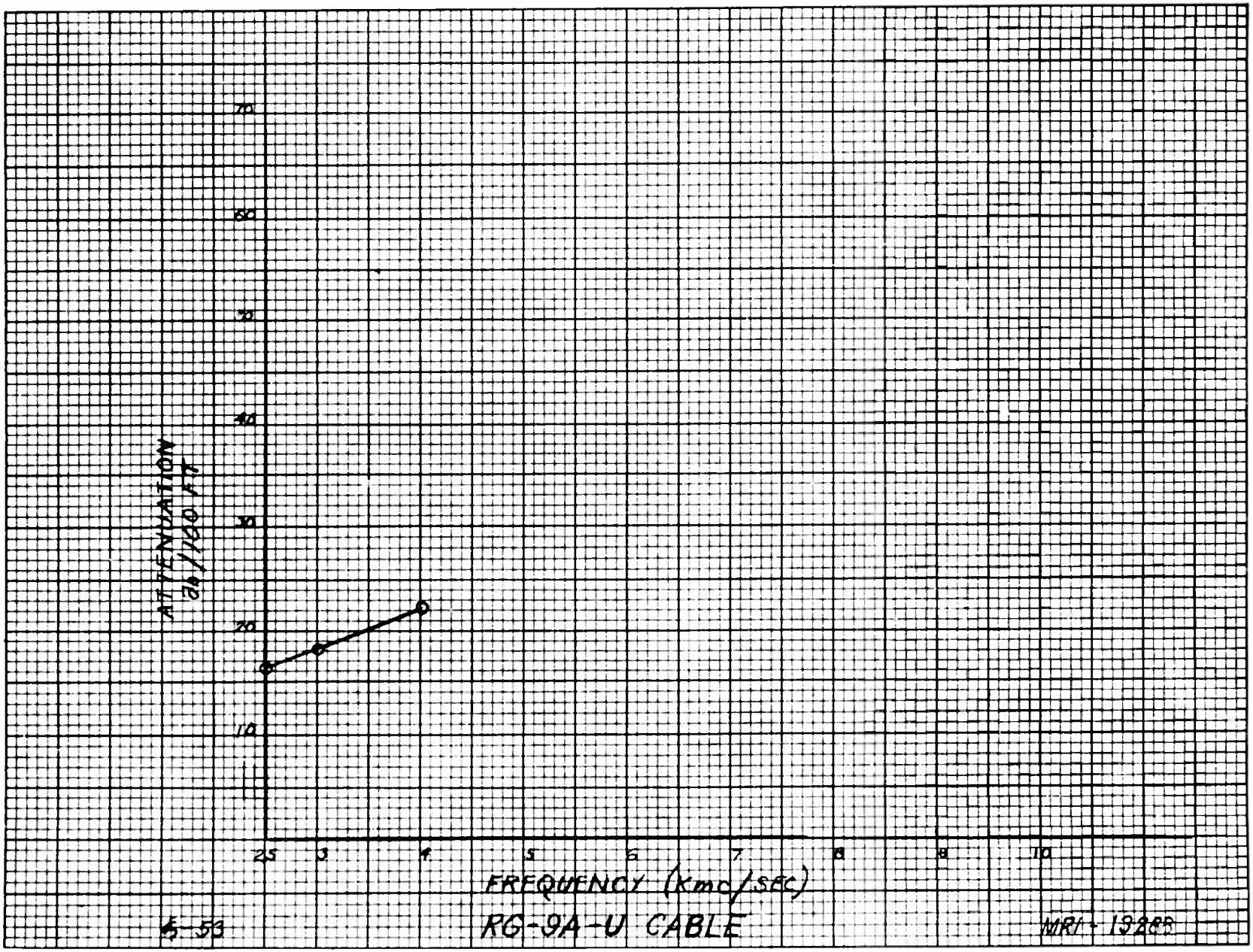
BALLANTINE VOLTMETER ATTENUATOR MEASURING SET-UP USING BUFFER CABLES

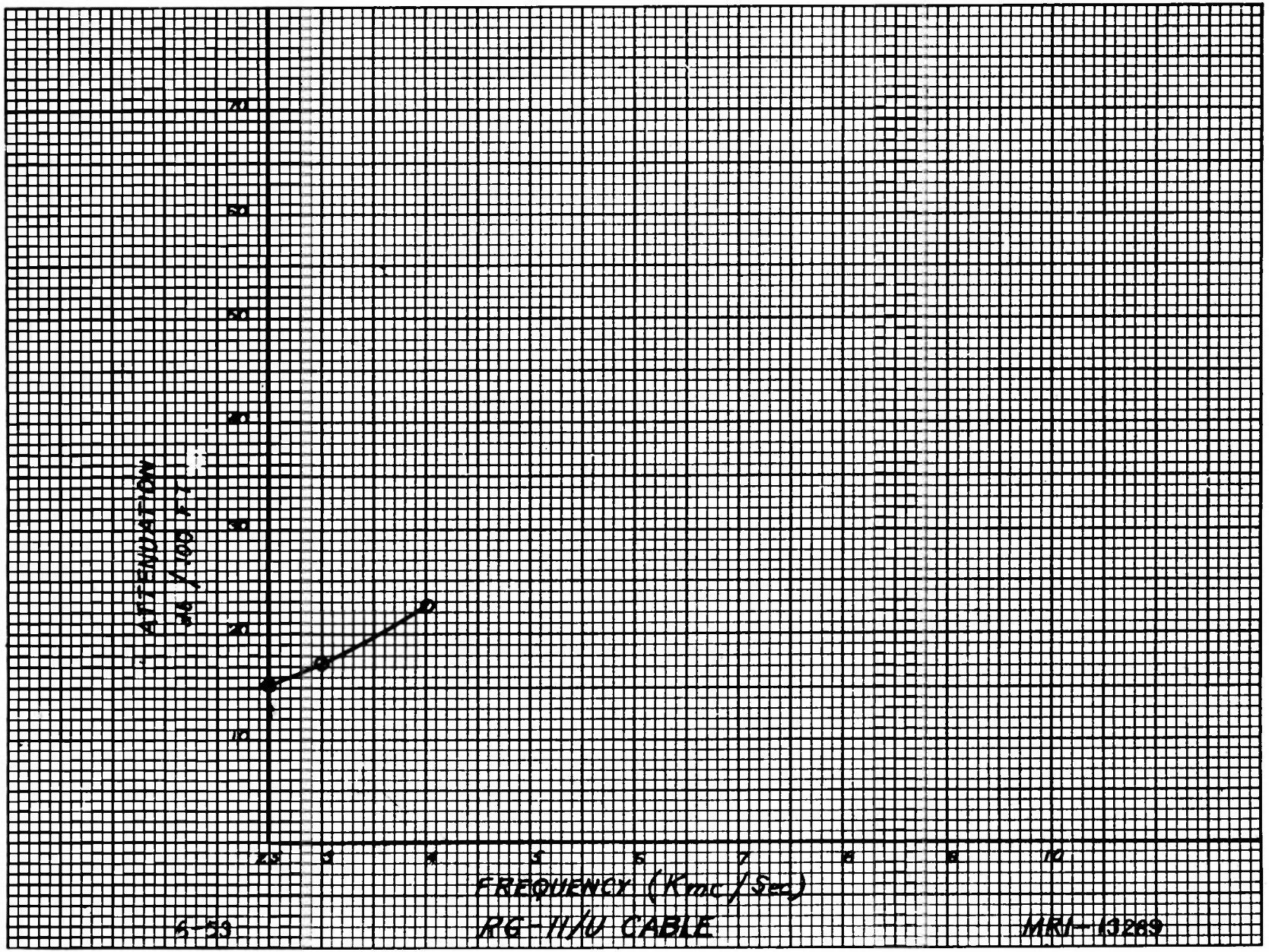


BALLANTINE VOLTMETER ATTENUATION MEASURING SETUP


70
60
50
40
30
20
10
ATTENUATION
DB/100 FT
2.5
3
4
5
6
7
8
9
10
FREQUENCY (Kmc/SEC)
RG-5A/U CABLE

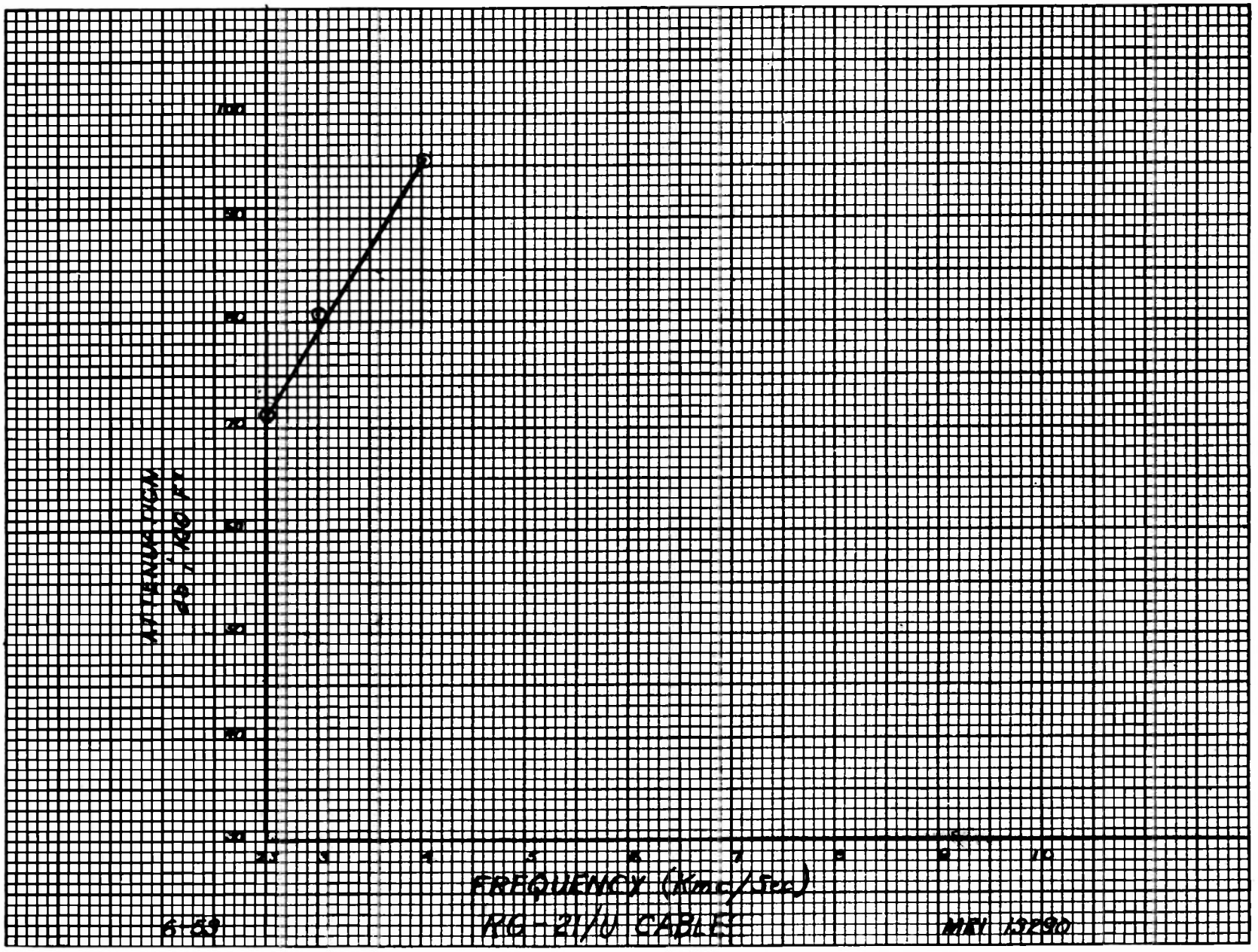
MRI-13287

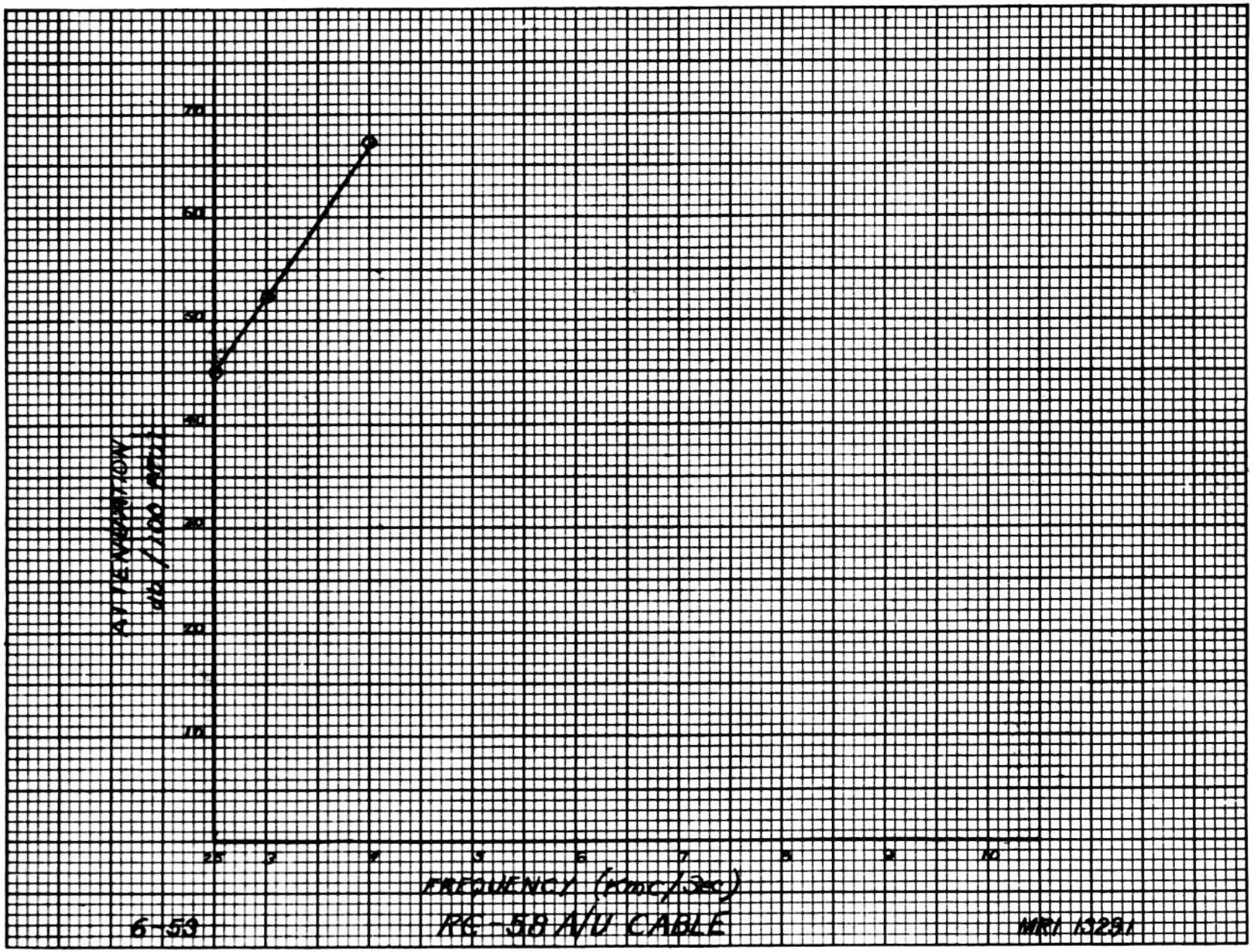

70
60
50
40
30
20
10
ATTENUATION
db/100 FT
2.5
3
4
5
6
7
8
9
10
FREQUENCY (Kmc/SEC)
RG-9A-U CABLE
5-53
WRI - 1928B



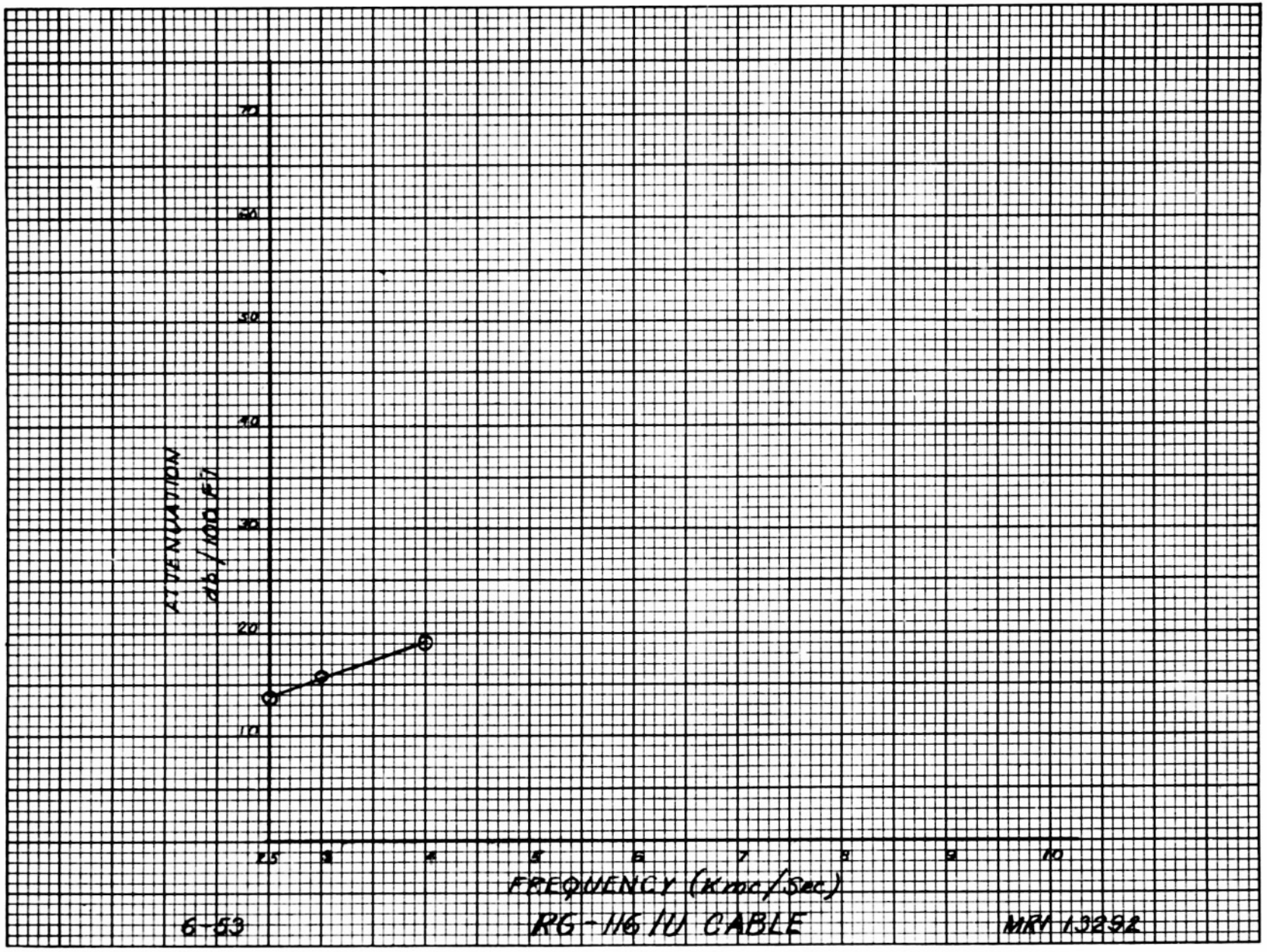
RG-11/U CABLE

MRI-13269


ATTENUATION IN DB/100 FT
100
90
80
70
60
50
40
30
2
3
4
5
6
7
8
9
10
FREQUENCY (Kmc/sec)
RG-21/U CABLE
6-69
MKI 13290



RG-58 A/U CABLE



6-53

RG-116/U CABLE

MRM 13292